Attachment 6

Utah Bioremediation, Landfarming, Stabilization, and Solidification Requirements

The purpose of this guidance is to provide the BLM and UDOGM Authorized Officer (AO), as well as the operator, with tools for making decisions on the selection of bioremediation, landfarming, stabilization, or solidification techniques. Also, a primary goal of this guidance is to insure contaminated sites are remediated to the extent necessary to protect the public from unacceptable risks potentially caused by exposure to contaminated media and decrease contaminant concentrations and/or minimize the potential for contaminant migration. The level of information necessary to determine the risk classification of a site will vary on a site-by-site basis depending on the nature and extent of contamination, site geology and hydrogeology and site proximity to receptors. Comparing the analytical results to the risk-based screening levels (RBSLs) will aid in selecting the appropriate mitigation strategy.

BLM references for bioremediation can be found in WO IM No. 99-061, February 5, 1999. UDOGM regulations for bioremediation and landfarming are located in Utah Administrative Code R649-9-4.

Feasibility for successful treatment can be researched utilizing the References section at the back of Attachment 2. Stabilization or solidification is addressed in the Interstate Technology & Regulatory Council's 'Development of Performance Specifications for Solidification/ Stabilization', July, 2011 and the 'Treatability Studies for Solidification/ Stabilization of Contaminated Materials', U.S. Army Corps of Engineers' Technical Letter No. 1110-1-158 28, February 1995. These documents provide useful evaluation methods for preparing treated material to meet remediation goals and establish a minimal set of properties for evaluation during field operations.

Treatment technique definitions:

Bioremediation of pit contents – Bioremediation involves either enhancing the growth of indigenous soil fungi and microbes, (biostimulation) or can be further promoted by adding nonindigenous, designer microbes (bioaugmentation). Oil may be treated in place (in-situ remediation) or contaminated soils may be moved to a better suited location for treatment (ex-situ remediation). Some contaminated soils may be left in place, allowing the inherent capabilities of naturally occurring microbes to degrade contaminants without taking any engineering steps to actively enhance the process (intrinsic bioremediation). Two requirements must be met for successful bioremediation; proper nourishment and favorable conditions. Proper nourishment includes oxygen, water, and nutrients. Favorable conditions include temperature, moisture, pH, and the minimization of chemicals toxic to the microbes such as salts.

Landfarming pit contents - Landfarming is the controlled and repeated application of wastes to the soil surface or treatment in windrows, using native microorganisms in the soil to naturally biodegrade hydrocarbon constituents, dilute and attenuate metals, and transform and assimilate waste constituents. However, inorganic constituents, e.g. salts, will not

biodegrade and may have long term detrimental effects on soil and vegetation. Transfer of drilling mud to UDOGM-approved landfarms is prohibited, see UDOGM's March 24, 2009 Notice to Oil & Gas and Disposal Facility Operators, Re: Drilling Mud. This Notice has been clarified and reiterated with an October 18, 2012 Notice located on UDOGM's website.

Stabilization of pit contents - Stabilization refers to those techniques that reduce the hazard potential of a waste by converting the contaminants into their least soluble, mobile, or toxic form (such as removal of free-standing liquids). The physical nature or characteristics of the waste are not necessarily changed by stabilization.

Solidification of pit contents - Solidification refers to techniques that encapsulate the waste in a monolithic solid of high structural integrity. The encapsulation may be of fine waste particles (micro-encapsulation) or of a large block or container of wastes (macro-encapsulation). Solidification does not necessarily involve a chemical interaction between the wastes and the solidifying reagents but may mechanically bind the waste into the monolith. Contaminant migration is restricted by vastly decreasing the surface area exposed to leaching and/or by isolating the wastes within an impervious capsule.

Discussion of Treatment Techniques

Not all drilling wastes are amenable to chemical fixation, stabilization, bioremediation, or landfarming treatments. For example highly saline drilling muds may not be suitable for bioremediation or landfarming if treated waste is to be applied to the land surface.

Stabilization and solidification are two different types of remediation methods, which prevent or slow the release of harmful chemicals from contaminated soil, sludge and liquids. These methods target treating petroleum wastes such as oil field waste and wastewater, drilling mud, cuttings and oil based drilling fluids. The chemicals are not usually destroyed but are prevented from migrating into the environment. The *stabilization* process alters the chemicals to become less harmful, or less mobile, by removing the free-standing liquids to prevent contaminant migration. Whereas, the *solidification* process essentially binds the contaminated waste and cements it into a solid matrix. By mixing with reagents and pozzolonic setting agents, the waste material hardens, which allows it to be safely left in place. Rain and ground water should be prevented from dissolving or removing chemicals from the treated waste material.

Historically, Portland cement, cement kiln dust, lime, lime kiln dust, fly ash, bentonite, gypsum and phosphate mixtures, and calcium oxide have been used most frequently as stabilization or solidification additives for treating drill cuttings and other types of wet solids. Use of Portland cement to solidify inorganic wastes has been a standard industrial procedure for over a decade. The high pH environment is extremely effective in containing metals and other solids.

Current EPA regulatory leaching tests are intended to provide a leachate that is representative of field leachates found either in a municipal solid waste landfill in the case of the Toxicity Characteristic Leaching Procedure (TCLP, EPA Method 1311) or after contact with acid rain

in the case of SPLP. With respect to TCLP in particular, the EPA Science Advisory Board and others have noted several additional limitations, which have bearing on leachability assessment for solidification/stabilization (S/S) materials. *Solidification* treatment technology often relies on the formation of a monolithic of treated material such that the majority of ground water (if present) flows around the treated material. Therefore, solidified waste will be analyzed with the Utah Non-hazardous E&P Exempt Waste Modified Leachate Test Procedure. *Stabilization* requires the addition of a hydrophilic material, which will be limited to clean soil borrow from onsite or offsite (fly ash is not approved for use in the stabilization process).

Treatment Approval Process

Prior to implementing S/S, bioremediation, or landfarming treatment a project plan must be submitted to the BLM or UDOGM AO for approval. The project plan, comprised of a closure plan and subsequent closure report, must include proposed waste treatment technique, oil content, water content, pH, SAR, specific conductance, and salinity of waste to be treated. Disposal offsite will also require submission of the approved landfill or landfarm facility information.

Pit Closure Plan

A pit closure plan must be submitted to the BLM or UDOGM AO, which at a minimum must include the following information:

- Site name (well name, API, unit, etc.)
- Legal description (Township, Range, Section, Quarter Section and latitude/longitude)
- Site geology and hydrology
- Potential contaminant receptor, e.g. human, livestock, wildlife, vegetation, ground water, or surface water
- Treatment contractor, or operator's in-house treatment designated agent
- Description of *proposed* treatment technique with chemicals, materials and equipment
- Area and depth of pit to be closed (provide site map with pit boundary and closure design diagram)
- Proposed waste sampling locations, procedures and equipment to be utilized
- Proposed laboratory analytical testing methodology (see Attachment 4). For solidified waste use Utah Non-hazardous E&P Exempt Waste Modified Leachate Test Procedure
- Estimated volume to be treated and buried in place **or** removed to an approved disposal facility
- Surface reclamation strategy
- Proposed project schedule with start and end dates

Pit Closure Report

A pit closure report must be submitted to the BLM or UDOGM AO, prior to final pit closure approval, which at a minimum must include the following information:

- Site name (well name, API, unit, etc.)
- Legal description (Township, Range, Section, Quarter Section and latitude/longitude)
- Treatment contractor, or operator's in-house treatment designated agent
- Treatment technique selected and implementation success, along with any problems encountered
- Review of analytical results using Tier 2 analysis and describe any potential receptors or environmental impacts
- Site map with post-treatment sampling locations, pit closure boundary and surface reclamation activities performed, e.g., final topography, drainage pattern, and vegetation
- Actual volume treated and buried in place **or** removed to an approved disposal facility accompanied by weigh tickets and/or manifests